

The "Floppy Diaphragm" Sign with Laparoscopic-Associated Pneumothorax

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ABSTRACT

Pneumothoraces in association with laparoscopy are uncommon and potentially disastrous complications that may also occur without adverse sequelae. The "floppy diaphragm sign" is a readily discernible and useful sign of a laparoscopic-induced pneumothorax. Tube thoracostomy is generally not indicated in stable patients as the pneumothorax typically resolves quickly upon desufflation of the pneumoperitoneum.

Key Words: Laparoscopy, Pneumothorax, "Floppy diaphragm."

INTRODUCTION

The development of a pneumothorax during laparoscopic operations is an uncommon but potentially disastrous complication,¹⁻⁵ frequently seen in elderly patients with cardiac and pulmonary compromise.⁶⁻⁸ Other laparoscopic complications that must be distinguished from a pneumothorax include carbon dioxide embolism, acute reductions in venous return, vasovagal responses, tachyarrhythmias, and pulmonary compromise.⁵⁻⁸ In most cases, a laparoscopic-induced pneumothorax (or "carbo-thorax") will resolve spontaneously with the release of the pneumoperitoneum.^{6,7,9,10} Otherwise, the physiologic embarrassment of a pneumothorax is readily cleared with tube decompression in emergencies. The key to effective management is early recognition, and the authors herein describe the "floppy diaphragm" as a readily-observable and intraoperative clue to carbon dioxide above the diaphragm.

MATERIALS

In a personal series of 1900 laparoscopic cholecystectomies, three patients were found to have the "floppy diaphragm" sign. With desufflation of the abdomen, the diaphragm bilowed inferiorly, thus reflecting the loss of negative pressure within the diaphragm. Each patient was a thin elderly female. The laparoscopic cholecystectomies were uneventful and lasted for less than 40 minutes. Chest x-rays in the recovery area confirmed pneumothoraces which decreased in size about 50 percent within an hour.

DISCUSSION

While laparoscopy was first performed in the 1890's, the first case of spontaneous bilateral pneumothorax in association with pneumoperitoneum was reported in 1939. In 1943, the first fatality reported in association with laparoscopic pneumothorax was attributed to "congenital" defects in the diaphragm found at the autopsy.⁴

Most pneumothoraces are attributed to defects of the diaphragm, but other causes include trauma to the diaphragm during operations, rupture of emphysematous bullae, or the diffusion of CO₂ through anatomical pathways.^{4,5,7,11,12} The elderly, and those with cardiac and pulmonary abnormalities, seem most susceptible to a pneu-

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mothorax.⁶⁻⁸ Complications include CO₂ embolism, decreased venous return, severe changes in heart rate, systemic vascular resistance, cardiac output, and pulmonary function.⁶⁻⁸ One possible mechanism of a pneumothorax is a leakage of CO₂ around the trocar sites into subcutaneous tissue. Older patients have lax subcutaneous tissue, so that could be one reason why older patients are more susceptible to a pneumothorax.⁷ Spontaneous pneumothoraces can result as CO₂ can pass through diaphragm openings along structures passing from the thoracic into the abdominal cavity, finding its way into the pleural cavity through the point of least resistance.¹¹

Many physiological problems occur as a result of a pneumothorax. A pneumothorax should be entertained if the patient has a fall in blood pressure, bradycardia, the pulse rate changes, tachycardia, surgical emphysema, or if ventilation is difficult.^{7,13} Other signs that a patient might have a pneumothorax include a decrease in arterial oxygen saturation,^{3,5,9,10} an increase in airway pressures,^{4,5,10} and an increase in end-tidal CO₂.^{4,5,10,14} One major consequence of a pneumothorax is a decrease in venous return.^{5,8} This decrease in venous return is caused by an increase in arterial filling pressure combined with inferior vena cava pressure. When the diaphragm is elevated, the intraperitoneal pressure increases the intrathoracic pressure, which also impedes ventricular filling.⁸ Most of the changes in cardiac output associated with a pneumothorax are due to increased abdominal pressure rather than the resorbed CO₂ and are reversible by desufflation.⁶

Other causes of pneumothoraces occur as a result of postoperative occurrences. After surgery, there may be no obvious factor that caused the pneumothorax, and it may not even develop in the immediate postoperative periods. One case in the literature shows a pneumothorax occurring postoperatively as a result of vomiting. The surgical procedure should not always be assumed to be the cause of a pneumothorax.¹⁰

Because of the potential complications associated with pneumoperitoneum, mechanical elevation of the abdominal wall has been evaluated. However, the view, and range of motion are inferior to conventional pneumoperitoneum.²

Although a pneumothorax is very rare, the complications associated with it can be disastrous. In 1992, Prystowsky et al. identified 70 cases of pneumothorax. Five had tension pneumothorax, and two of these died. Twenty-one percent had a pneumothorax subsequent to laparoscopy, and the remainder had the pneumothorax after pneumoperitoneum for the treatment of intestinal or pulmonary tuberculosis.⁴

Morbidity and mortality should be reduced by early recognition and prompt reaction. The "floppy diaphragm" sign is a useful sign to the laparoscopic surgeon when the patient becomes unstable.

CONCLUSION

Most pneumothoraces in association with laparoscopic procedures will resolve with desufflation of carbon dioxide from the abdominal cavity. However, an undetected pneumothorax during a laparoscopic procedure may cause cardiopulmonary instability. The most expeditious way to detect or confirm the presence of a pneumothorax is to inspect the diaphragm as carbon dioxide is released from the abdominal cavity. If the diaphragm is "floppy," a pneumothorax may have occurred, and the patient should be monitored postoperatively to insure that the pneumothorax resolves on its own. Tube thoracostomy may be appropriate if the pneumothorax is observed early in the operation or if hemodynamic instability does not respond to desufflation.

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